# Empirical Test of Imperfect Competition in Semi-Perishable Produce

## Empirical Implications of Trigger Model of Tacit Collusion

Retailer margins are determined by both the prices they charge consumers and the prices they pay to shippers for their fresh produce. Therefore, in order to determine how much of the weekly variation in margins is due to the ability to set prices on either the buying or selling sides of the profit equation, and how much is due to simply market forces, we need to account for the factors that influence supply and demand. Further, by allowing both the raw product supply and retail demand curves to change slope, or pivot, we can estimate the extent to which variation in retailer-shipper margins depends upon retailers' use of the ability they may have to set prices (Bresnahan).

To accomplish this, we estimate equations representing: (1) produce supply, (2) retail demand, and (3) retailer margins. Besides changes in supply and demand, we also account for changes in retailers' costs - primarily labor used in stocking shelves and customer service, energy to heat and light stores, and business services such as insurance, real estate, and finance - so include measures of these costs in the margin equation. According to our conceptual model of retailer behavior, however, we also need to allow for the fact that rivals interact in different ways over time, alternately punishing or cooperating according to their assessment of rival behavior.

## Data Analysis Method

The usual approach to estimating models of imperfect competition assumes that sample margins reflect a single set of firm strategies and market conditions. However, if retailers behave the way we believe they do, then margins should reflect alternating strategies - one in which retailers cooperate and the other in which they punish each other. The problem here is that we never know when they are cooperating and when they are punishing. Therefore, our estimation procedure is designed to estimate the probability of punishment or cooperation along with parameters that measure the degree of price-setting ability that may be inferred. Essentially, margin data are assumed to be produced by a *weighted average* of the two types of behavior that we expect to see in the real world. If this model is correct, then we should observe regimes in which retailers' prices in input and output markets are indistinguishable from those that we would observe in competition, and others in which they are clearly making cooperative profits. Identifying these regimes requires a large volume of very detailed pricing, sales volume, and cost data.

## Sample Description

Unlike prior studies that employ this methodology in aggregate industry-level data, we estimate the effect of cooperative pricing on retailer-shipper produce margins using a sample of firm-level price, cost and shipment data. Further, to account for heterogeneity in regional produce markets, we estimate independent models for each chain and market in our sample. Specifically, the sample includes data for retail chains in Albany, Atlanta, Chicago, Dallas, Los Angeles, and Miami. For each chain, we have 104 weekly observations over the period January 1998 to December 1999 consisting of price per pound and number of pounds sold from all stores of a given chain. For some commodities, however—most notably fresh oranges, grapefruit, and, to a lesser extent grapes—the sample does not consist of the full 104 weeks because we excluded weeks of no domestic U.S. shipments.

For each of our broad category definitions, we select a specific product as representative of the price dynamics of the entire category in order to control for aggregation errors over products of different quality, local supply, or local preferences. Specifically, the analysis concerns Washington Red Delicious apples, California green seedless grapes, California fresh Navel and Valencia oranges, and Florida grapefruit. Although our grape-product definition includes several different varieties, primarily Thompson seedless and Perlettes, this aggregation is necessary because there is no distinction between varieties drawn at retail. In the case of oranges, we combine Navels and Valencias due to the relatively short shipment season of each and the need to preserve as many observations as possible for the estimation of the model parameters. Initial estimates of an aggregate supply function show that the Navel and Valencia supply functions are similar after allowing for seasonality, so this variety aggregation is thought to be reasonable. Further, it is hoped that by comparing the results across commodities, chains, and markets, we will be able to provide some degree of qualitative evidence as to whether the use, or nonuse, of market power is typical of the produce industry in general or is specific to individual commodities, chains, or markets.

## Data Sources and Data Description

All of our empirical results refer only to those companies from which we have sales volume and retail-price data. The list of participating companies depends, in turn, on those who are willing to share scanner data to a partner data-vendor. In this case, the source of all retail data is FreshLook Marketing of Chicago, Illinois. These data, commonly used for category management purposes by commodity commissions and large shippers, includes measures of: (1) weekly movements (quantity, in lbs.) of a given UPC or PLU coded product by chain and retail market; (2) listed selling price of the commodity by chain and market; and (3) number of stores within the chain selling the product. The exact definition of retail price used in estimation varies by commodity.

For apples, the price represents an average over all non-organic Red Delicious sales each week. Price differences between bagged and bulk apples were adjusted using the method suggested by Goldman and Grossman and applied to food demand analysis by Cox and Wohlgenant. In this way, we define a bulk-equivalent apple price for each market-chain-week observation. Although the retail price for individual apple varieties and sizes typically change very little over the sample period, it is necessary to aggregate this way in order to match our shipping-point price data, which do not differentiate among apples of the same variety beyond controlled versus regular storage.

For table grapes, the retail price is defined as the price reported for the particular green seedless variety sold in each market by each chain each week. Initial model estimates attempted to include sales from both Chilean and other offshore sources and U.S. sources in a complete, year-round model. However, efforts to estimate the supply response of imported grapes were unsuccessful, so we chose to focus instead on grapes of U.S. origin and a sample that represents only those weeks when U.S. grapes are sold. Within the class of "green seedless grapes," there are not only several possible source regions, but many different varieties as well. Because the retail data do not consistently break out these varieties, however, we are forced to aggregate over all that meet this general definition. Fortunately, these varieties tend to overlap very little and represent relatively discrete parts of the sample period, so this retail price should correspond well to our shipping-point price. Further, all sales are random weight, so no correction between product forms is required. Fresh oranges, however, are sold in both bagged and bulk form, so a similar correction to that made for apples is also made in this case.

Although it would be preferable to focus on a particular variety of oranges, neither Navel nor Valencia oranges alone represent a marketing window of sufficient length to allow enough degrees of freedom to estimate the model. Therefore, we consider an aggregate "fresh orange" category consisting of both varieties. As in the grape case, the fact that the seasons for these varieties overlap very little serves to minimize errors induced by product aggregation. To further reduce the possibility of inducing such error into the model, we account for the different shipping seasons within our econometric procedure through a fixed-variety effects approach. Therefore, for each product we attempt to ensure that the calculated retailer-shipper margin represents actual market results and, as such, does not suffer from any external source of bias. For similar reasons, we combine red and white grapefruit prior to estimating the market structure models for these products. Further, we exclude those weeks in which domestic shipments were effectively zero—leaving 80 observations for each market. To explain variation in this margin, we estimate the cost of buying and marketing fruit using grower prices and price indices for the retailer cost function that we describe next.

Labor constitutes the major component of retailers' costs. Wage data for workers in the retail grocery industry are from the Bureau of Labor Statistics *National Employment, Hours, and Earnings* report on a monthly basis for 1998 and 1999 (U.S. Department of Labor). This report also provides average weekly earnings for workers in the advertising, business services, and the FIRE (finance, insurance, and real estate) sector. These variables constitute our measures of input prices at the retail level. All monthly data are converted to weekly observations using a cubic spline procedure.

Marketing costs also include transport costs from the growing region to the destination market. For this, the USDA-AMS *Truck Rate Report* provides estimates of weekly trucking costs between a number of source and destination points for the sample of fresh produce considered here. Because the *Truck Rate Report* does not provide a consistent set of rates for all weeks in which there were positive shipments, numerous assumptions were made in developing continuous series for each commodity and market. In the case of grapes, weeks for which rates were not quoted were inferred from contemporaneous rates for lettuce and tomatoes for the same terminal market. Adjustments to the vegetable cost data were made based on the average differential for weeks in which both commodities were quoted for a similar source-destination pair. This procedure was also used for periods in which orange transport data were not reported.

Estimating the supply curve for fresh produce requires data on farm input prices, primarily associated with harvest, and prices of alternative uses for each fresh commodity. In each case, the output price is defined as the shipping-point price paid at the source on a free-on-board (FOB) basis. Any difference between this and the farm-gate price is due to grading and packing charges levied on the grower by the shipper. For Washington apples, the price represents a weekly average over all sizes and grades of Red Delicious apple as reported by the Washington Growers' Clearing House. Because the proportion of regular-storage and cold-storage apples that are shipped varies each week, the price is simply a weighted average of each type. To estimate the extent of any rotation in the supply curve (i.e., non-parallel shifts required to identify the market power parameter), this price is multiplied by the harvesting wage that is relevant to each product. For apples, this is the average wage of harvest workers in Washington State, which is obtained from the Washington State Employment Security Department's *Labor Market Information* report. Similar data for California are used for table grapes and fresh oranges and for Florida in the fresh grapefruit model and are obtained from the USDA-NASS *Farm Labor* publication.

Commodity price and output data are either from the appropriate commodity organization or from USDA-AMS sources. Specifically, shipping-point prices for regular and cold-stored Red Delicious apples are from internal reports generated by officials at the Washington Growers' Clearing House. These reports also provide monthly shipments for both types of apples to all domestic destinations. For table grapes, similar price data are from the California Table Grape Commission, while shipments are from the USDA-AMS *Shipment Report*. For purposes of this research, shipments were defined to include only those from domestic U.S. sources. As mentioned above, periods during which the U.S. market was supplied from Chilean or other import sources are excluded from the analysis. This is also true for fresh oranges and grapefruit as the period of analysis includes only those weeks in which U.S. fruit was sold through retail markets. For all fresh citrus, both the shipping-point price and shipment data are from the USDA-AMS. Although these shipping-point data include prices for a range of sizes, the retail data do not, so we construct an aggregate consisting of a simple average price per week. Implicitly, therefore, this procedure assumes a uniform distribution of shipments by size. Finally, all prices are converted to dollars per pound in order to compare directly to the retail price data.

To test the hypothesis that retailers' ability to set price falls with the amount of weekly shipments, we allow a parameter that measures the degree of market power in each model to vary with total weekly shipments of each commodity. These data were obtained directly from USDA-AMS officials and include all shipments either to or within the U.S. on a weekly basis. Therefore, we include imports to the U.S., but exclude U.S. exports abroad.

Although it would have been preferable to allow each conduct parameter to vary with some indicator of industry structure such as the level of concentration or a non-endogenous measure such as any non-strategic entry barriers, high-frequency data are not available for any of these variables. Therefore, we are left to infer any change in the ability to price strategically from our parameter estimates and observed trends among retailers in each market. Despite these limitations, however, we are confident that the data described here provide the most detailed picture of fresh produce market behavior currently available.